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Responses of soil biota to organic waste recycling for sustainable oil palm cultivation

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Context

- Sixteen million hectares of oil palms have been planted in tropical area within the last few decades with dramatic changes in land-use
- Soil biodiversity in oil palm plantations has been little investigated
- Palm oil mill organic wastes are often recycled in plantation as substitute for mineral fertilisers

This study aims to assess the effect of organic waste recycling on soil biodiversity in a mature plantation in order to develop sustainable practices

Material and methods

- Observations were made in plantations located in Sumatra, Indonesia. Plots received 60 t.ha^{-1} **EFB** (**empty fruit bunches**, an organic mill by-product) every two years, on the palm inter-row, along to the harvest path, were compared to control plots without EFB application (Conventional: Conv)
- Based on the standard spatial organisation and practices in plantations, 5 zones were defined (Fig1)
- We assessed soil macrofauna, nematofauna and bacteria (terminal restriction fragments length polymorphisms- TRFLP), together with soil physical-chemical characteristics
- Temporal variability (under EFB) was assessed based on a time-sequence with observations undertaken 1, 3, 6, 12, 18, and 24 months after EFB application

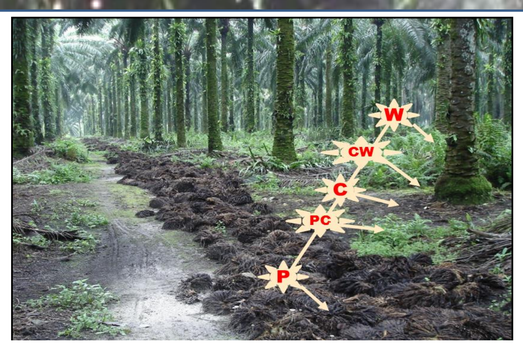

Fig 1: Sampling zones around oil palm. C=circle, P=Path (here with EFB application), W=windrow, PC and CW: transition zones

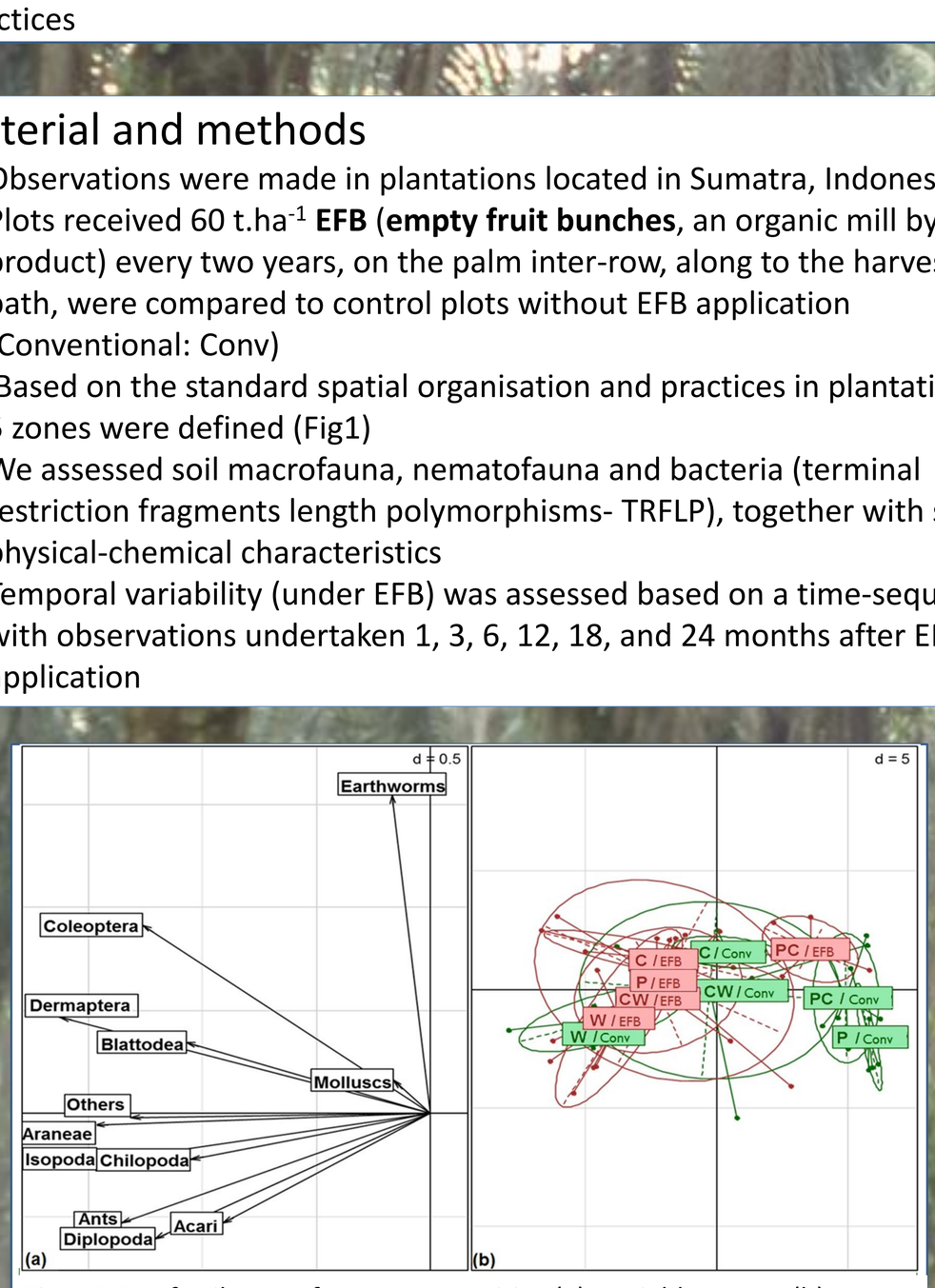

Fig 2: PCA of soil macrofauna communities (a): variables: taxa. (b) Ordination of sampling zones in the plane defined by the first two axes. Labels corresponds to the barycentres of zones/treatment (Monte Carlo test, $p < 0.01$, Obs.=0.42). EFB treatment: 3 months after application

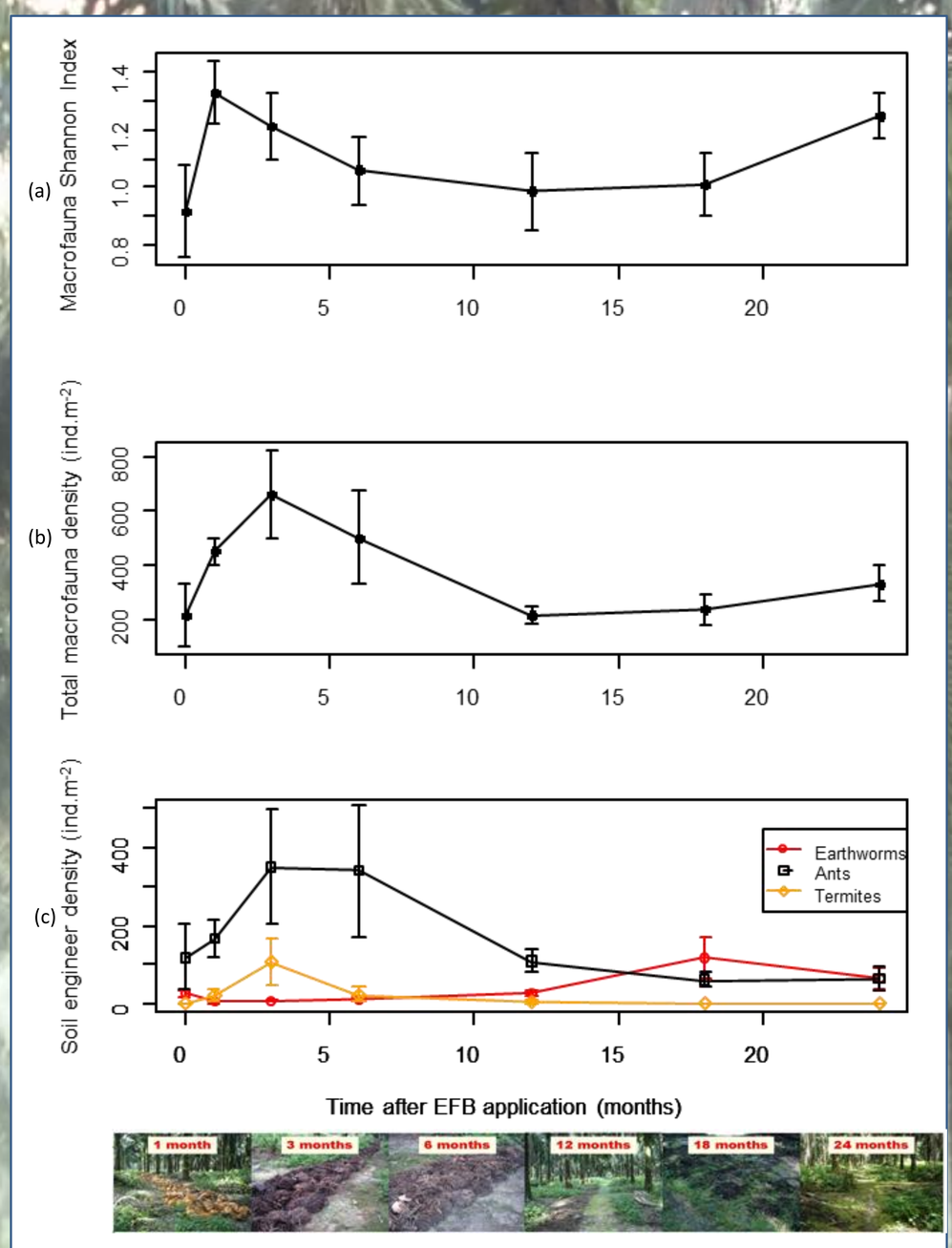

Fig 4: Temporal variation of (a) Shannon index of soil macrofauna, (b) total soil macrofauna density and (c) soil engineer densities under EFB (P), after EFB application. 0 = Conv

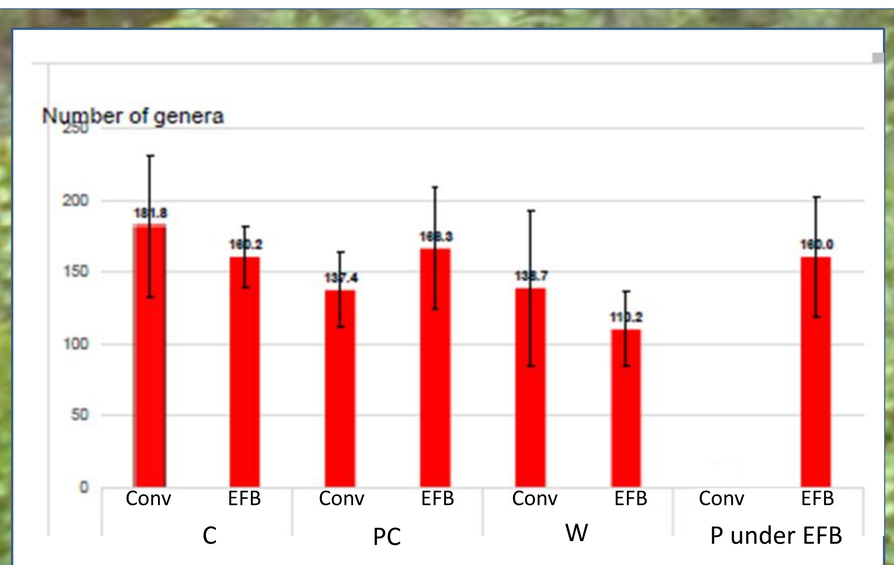

Fig 3: bacterial genera abundance (*TRFLP* technique) , Conv=Conventional, EFB = Empty Fruit Bunches treatment

Results and discussion

- Zones with EFB applications showed higher earthworm density and "maturity index" of nematodes communities. Axis 1 of the PCA ranked sites according the treatment and revealed the influence of EFB application mostly on P, C and CW zone (Fig 2)
- Bacterial diversity (number of genera) was higher in the EFB treatment, in the harvesting path and in the circle than in the windrow (Fig 3). 26 new fragments were found in soil under P zone, mostly uncultured bacteria and some cellulolitic bacteria such as *Saccharomonas sp.*, *Cellulomonas sp.*
- Three successive periods were identified (Fig 4): a disturbance period (0-6 months), with reduced density of earthworms, diplopods and nematodes, but a higher density of ants; a resilience period (6-18 months); and a long-term improvement period (24 months, *i.e.* just before new EFB application) characterized by a high density of earthworms and a high Shannon index

Conclusion and perspectives

- Our results demonstrate spatial and temporal variation in biodiversity and density of soil organisms in oil palm plantations, and a significant impact of EFB application
- This research is the first stage towards evaluating current field practices and developing new strategies for maintaining and enhancing soil biodiversity and related services for sustainable oil palm cultivation

References

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